NATURAL RESOURCES CONSERVATION SERVICE

WATERSHED SCIENCE INSTITUTE

Case Summary Report

Examining A 1930's Restoration of the

Winooski River Watershed, Vermont

CONTENTS:

- Introduction
- Background
- Documentation
- Watershed Setting
- Stream Corridor Treatment
- Watershed Treatment
- References
- Return to Project Vermont CDROM

Figure 1. Watershed treatments are readily apparent after two years (July, 1940). Compare this to figure 2, before. Formerly eroded hillsides to the right are no longer visible. The broad gap in the forested riparian corridor (lower center) has been planted to trees (200 feet wide strip) and the eroded streambank and flood chute have been treated using soil bioengineering.

(Photo 2 CD)

INTRODUCTION

In the late 1930s the Soil Conservation Service (now the Natural Resources Conservation Service) helped landowners implement an extensive watershed restoration effort, known as "Project Vermont" in the Lower Winooski River Watershed, Vermont. Many of these measures are functioning well today, over 55 years since installation! Tree plantings along the corridor have matured with diameters as great as 45 inches and heights exceeding 100 feet. The wooded corridor averages 50 feet wider than the 1930's. Forestland has increased by over 300 percent. This shows that a comprehensive, integrated approach is appropriate and in this watershed has been lasting and effective.

This project is particularly important today because of the wealth of data, photographs and other documentation available that form the basis for dramatic 'before' and 'after' conditions.

There is complete aerial photography and over 600 photo prints that provide a chronology of the completed conservation practices. Three successive studies document the performance of the project.

BACKGROUND

From 1927 to the late 1930s the Winooski River Watershed suffered severe damage along the main river corridor and throughout the uplands. Most of the damage was caused by three major floods occurring in 1927, 1936 and 1938, land use encroachment on the river, and inappropriate upland land management. The recurrence intervals for these floods were 500-year, 20-year and 10-plus years, respectively.

Figure 2. Landscape before the project (1936). A mild, long drought, overgrazing and poor farm management turned these hilly pastures into large sandblows, while floods ravaged the bottomlands

Following the floods, the Soil Conservation Service (SCS) joined with the University of Vermont (UVM) and local landowners to formulate a comprehensive, low-input approach to restoring and protecting the watershed. This approach relied heavily on plantings or a mix of plantings with mechanical techniques to stop land losses and restore the vegetated buffer along the river corridor; and in the uplands to make agricultural land sustainable and restore deteriorating forestland. Many of the techniques used were considered experimental at the time, and these same techniques are enjoying a resurgence today as environmentally compatible and viable methods.

Figure 3. Most treatment measures required extensive plant materials and hand labor. Workers are installing live willow stakes and brush matting on a terraced streambank (September, 1938). (Photo 22 CD)

The measures were installed over a period from 1938 to 1941 primarily by the landowners. They provided extensive labor and occasionally heavy equipment for moving earth, and transporting and placing materials too heavy for laborers. SCS provided interdisciplinary (agronomy, biology, forestry, soil conservation, soil science and engineering) technical assistance in planning, design and installation. UVM provided substantial educational services for marketing, operating, and maintaining the project measures.

DOCUMENTATION

During its planning and implementation, the project was documented in detail with drawings and specifications for each of the treatment sites, black and white photographs and aerial photos showing before, during and after installation conditions. The photography remains, but the detailed drawings were lost except for those showing herbaceous plantings. Three post-installation studies also provide extensive documentation of the project's performance. The first is USDA Circular No. 837, "Streambank Erosion Control on the Winooski River, Vermont," Edminster et.al., October 1949. This 54-page circular summarizes and evaluates the first five years of the project's performance.

The second evaluation of the project is reported in a masters thesis entitled "Evaluation of Erosion Control Measures on the Lower Winooski River, Vermont," Joseph R. Kasvinsky, October, 1968. This 96-page report is in a large part based on detailed resurveying of over 50 percent of the original 29,500 feet of river treatment. It evaluates the condition of the project measures after more than 25 years of performance.

The third detailed review was conducted in 1995 nearly 55 years after completion of the project. This two-year study was conducted as an Americorps project in cooperation with the Natural Resources Conservation Service (NRCS). The findings are published as "The Winooski River Watershed Evaluation Project Report," J. Ryan and H. Short, September, 1995.

More than 50 out of 92 demonstration sites still function today. The studies all found that the most successful measures generally included a mix of vegetative and mechanical treatments at each site.

WATERSHED SETTING

At 1,076 square miles, the Winooski River is Vermont's largest inland drainage basin. The river enters Lake Champlain at the terminus of the project. Project Vermont encompassed the lower 33 miles of Winooski River corridor and its immediate drainage area. Table 1 provides selected characteristics.

Today, farming is far less intensive in the uplands of the watershed than in 1938. Residential development and forestland are the major successors. The floodplain land use remains similar to that of 1938.

In 1938, ninety percent of the watershed had appreciable soil erosion. In 1995, this has dropped to less than 1 percent and occurred primarily along the river and its tributaries, isolated gullies, and isolated parcels undergoing development.

In the 1930's overgrazing, poor soil conservation practices on cropland, removal of riparian buffers and forestland clear cutting all resulted in excessive erosion. Ice flows and jams further exacerbated river bank erosion during snowmelt runoff. These stresses continue to occur today, but their impacts are minimized by the intact, riparian system.

Table 1 - Selected Watershed Characteristics

FEATURE	SIZE
Watershed Area	71,100 acres
River Length	33 miles
Thalweg Gradient	0.12 percent
Floodplain Width	2,000 feet average
Watershed Slope (Average)	10 percent
Predominant Soils	Silt Loam
	Fine Sandy Loam
Land Use - 1938	27 % cropland
	48 % pasture
	21 % woodland
	4 % other
Land Use - 1995	9 % Cropland
	3 % pasture
	66 % Forestland
	22 % other

STREAM CORRIDOR TREATMENT

The project used a variety of treatment measures along the river and its corridor to control bank losses, restore buffers and heal overbank flood flow channels. These included livestock exclusion, plantings, bank stabilization using biotechnical methods, and structural methods

Livestock Exclusion

Excessive livestock grazing resulted in the loss of riparian vegetation on the streambank and in the corridor. Fencing was installed to exclude cattle from these areas. On straight reaches fences were placed 15 feet from the top of bank, 200 feet or more on outsides of curves and 200 feet in flood overflow entrance and exit sections.

Figure 4. A previously, heavily-grazed streambank was fenced (right) to exclude livestock . Tree revetment (left center) was installed 8 months prior to this photo and had just endured a 10 year- flood. (September, 1938) (Photo 52 CD)

Biotechnical Methods

Sloping and Planting

Eroded streambanks were graded to a stable slope and generally planted with willow species. This approach was used only where the main river current was offshore or away from the treated section.

Figure 5. Sloped bank 2 months after planting with willow cuttings (June, 1938). Elaborate piling network at channel toe in background failed completely in eight years from ice action and bank seepage. (Photo 47 CD)

Sloping, Planting and Brushmatting

Brushmatting was applied over sloped and planted bank reaches thought to be more threatened by ice action, but still not being undercut. A layer of hardwood brush was fastened down on the plantings with stakes and wire.

Figure 6. A severely eroded slope has been shaped, planted to red osier dogwood and willow and brush- matted using live willow stakes (note in foreground). Pile jetties have also been installed intermittently at the toe. (Mar., 1938). (Photo 67 CD)

Figure 7. Same vantage point as figure 6, taken April, 1995. Note the large trees on the upper bank. The lower bank which receives substantial ice flows remains intact and well established with grasses and shrubs. (Photo 68 CD)

Sloping, Riprapping Toe, Brushmatting, and Planting

This practice was commonly applied to areas where bank undercutting occurred. The treated cross section included angular rock riprap imbedded at the slope toe and upslope to two or more feet above normal waterline, then brush -matting to the top of bank. Plantings were then made through the brushmatting. The brush -matting kept the bank stable until appropriate planting seasons.

Figure 8. Workers prepare slope for brushmatting and planting of willows (September, 1938). Rock riprap has been hand placed at toe of slope. (Photo 33 CD)

Figure 9. Same site as Figure 8 taken in April, 1995. Note the height and trunk diameter of the willows. (Photo 35 CD)

Table 2 - List of Plant Species Used on Slope Plantings

Species	No. of Cuttings/ other
Purple-Osier Willow	89,000
White "native" Willow	545,000
Poplar	12,000 plants
Boxelder	38,000 plants
Red-Osier Dogwood	23,000 plants
Speckled Alder	Large Amounts in Brush Mats

Others used: Silver Maple, Hackberry, Northern Red Oak, European Mountain Ash, Virginia Creeper, Lilac, Black Locust, Red Pine, Sugar Maple, White Pine, Arborvitae, Beachgrass

Structural Methods

Whole Tree Deflectors

This method was applied in reaches where near- shore water was deep (up to 14 feet) and bank voiding was occurring. The purpose of this treatment was to trap sediment and rebuild the voided section. Trees with butt diameters of 2 to 3 feet and intact branches were placed longitudinally along the river bank. Tree butts and tops from successive placements slightly overlapped. The butts were cabled to wooden piles driven 8 to 10 feet into the bank. The slope above normal waterline was brushmatted and planted.

Figure 10. Whole tree deflectors after three years of installation (January, 1941). Compare to 'after' installation in Figure 4. Note the sediment accumulation and growth that has occurred among the trees as well as the bank. Ice as seen here was a major nuisance to some installations. (Photo 54 CD)

Log Pile Check Dams, Buffer Plantings and Tree Barricades

Log pile check dams were constructed at the entrances of flood overflow channels and filled with one person size rocks for ballast. These served as barriers to overbank flow along channels sculpted by previous floods. They were installed in conjunction with extensive buffer plantings and in some cases whole, dead tree barricades that were secured with cable parallel to the river along the top of the denuded bank.

Figure 11. Looking downstream towards log pile check dam to the right; whole tree barricade, left center; and buffer plantings, far left (August, 1941). (Photo 100 CD)

Figure 12. Looking upstream along same river reach as Figure 11(Fall, 1994). The blocks in foreground were ballast to the tree barricades, long gone from the system. Note the well established, mature buffer plantings and intact streambank. The buffer plantings have held and are now mature trees, right. (Photo 101 CD)

Rock Filled Log Crib with Buffer/ Filter Planting

At overbank locations where flow threatened buffer plantings, log cribs were inset parallel to the bank and filled with rock. Various tree species were planted as a 200 feet or wider buffer behind the cribs. The cribs provided interim protection until the trees became well established.

Figure 13. Workers preparing subgrade for stone-filled log crib to close a severe flood chute gap (upper right). (January, 1937) (Photo 86 CD)

Figure 14. Streambank with stone-filled log crib of Figure 13, after bank and buffer plantings, July, 1937. (Photo 87 CD)

Figure 15. Photo at same location as Figures 13 and 14, Fall 1994. The site is very stable with trees and thick understory from bank and buffer plantings. (Photo 89 CD)

WATERSHED TREATMENT

The Vermont project encompassed 340 farms over an area of 71,000 acres. There were many problems to address on the uplands. Both water and wind erosion were prevalent. Soil organic matter was completely gone in some areas. Cropland had low productivity. Pastures were frequently overgrazed. Forestland had been clear cut in many areas and was often subject to grazing. Cover for wildlife was sparse.

Out of these, 189 farmers cooperated in developing conservation plans for their farms. These covered 36,770 acres and cooperators applied practices to 24,416 acres. Each conservation plan provided for comprehensive management for sustainable farming, grazing, forestry, and wildlife.

The cropland practices included contour strips, contour tillage, cover crops, crop and pasture rotation, grass and legume plantings, diversions, grassed waterways, log culvert crossings, contour furrows in pastures, livestock fencing, hedgerow and field border plantings, reforestation and sustainable forestry practices.

Wildlife habitat improvement practices provided connectivity among the cropland, pasture and forestland and included hedgerow plantings as travelways, food sources and cover, livestock exclusion to encourage understory herbaceous growth for cover and food sources, snag creation for small mammals and birds, and slash pile shelters for rabbit and grouse cover.

Today, the success of cropland and pasture management practices are well known and documented. However, the upland reforestation efforts of this project are particularly noteworthy. During the project 2,268,000 plantings of white, red, scotch, pitch, and jack pines; white and Norway spruce; European larch; hemlock; black locust; and white ash were made. These were typically planted in the higher terrain, along gullies, knolls and steep ravines and frequently on soils nearly barren of organic content.

Figure 16. A pasture in the watershed uplands shortly after treatment, June 1938. Brush fences, center, were placed to reduce wind effects while tree plantings became established. Note nearly all topsoil is missing. (Photo 126 CD)

Today sampling of these sites shows a soil organic layer of from 3 to 12 inches on previously sand blown areas. Healthy vegetative overstory exists with heights ranging from 60 to 100 feet, and native species, such as sugar maple are returning.

The impact of the reforestation has been dramatic. Forestland in the watershed has increased threefold from 1938 to 1995.

Figure 17. The same location as Figure 16 in February, 1996 showing the heavy, red pine plantings and forest floor mantle. Topsoil is now 3 to 12 inches deep. (Photo 127 CD)

SUMMARY

Although the Winooski Project was considered a test in the 1930's, there were many highly successful elements relevant to NRCS watershed work today:

Landowner participation in the project was very strong. The project had an effective information and education component that convinced landowners of the needs for their participation. A number of innovative techniques were used including scaled, physical models of demonstration farms showing before and after project conditions, including details on practices.

Landowners were empowered to carry out the restoration measures using low cost approaches (often using materials from the farm). These were accompanied by technical assistance, labor and equipment.

The project recognized the importance of landscape relationships and emphasized comprehensive treatment of the watershed rather than isolated, individual problems.

The project stressed the use of an interdisciplinary technical team for planning and implementation.

The river restoration aspect of the project used new and in some cases, experimental methods. Today these are recognized as viable biotechnical approaches.

Were this work being undertaken today, there are other elements that could bring additional value:

Biota needs in and linkages among the soil, terrestrial, riparian and aquatic ecosystems and the interaction among these systems.

Emphasizing the integrated use of more sciences including terrestrial ecology, plant ecology, aquatic ecology, landscape ecology, soil ecology, and stream mechanics.

Geomorphic factors in understanding the river's behavior.

Even so, the Vermont project is a clear example of restoration through stewardship. While certain aspects of the project are site and region specific and caution should be used in extrapolating specific techniques, the broader message of comprehensive watershed understanding and treatment is universal.

References

1. U. S. Department of Agriculture, Soil Conservation Service. 1949. Streambank Erosion Control on the Winooski River, Vermont. Circular No. 837. Washington, DC

2. Kasvinsky, J. R. 1968. Evaluation of Erosion Control Measures on the Lower Winooski River, Vermont. Master's Thesis to the Graduate College, University of Vermont. Burlington, VT

3. Ryan, J. and Short, H. 1995. The Winooski River Watershed Evaluation Project Report. Americorps - Corporation for National and Community Service and USDA - NRCS. Williston, VT

4. U. S. Department of Agriculture, Natural Resources Conservation Service. Photographs on file. Williston, VT

Figure 18. A changing watershed today (February, 1996). Compare this landscape with that of Figure 2 which was taken at the same location. The fragile, forested uplands that resulted from project treatment are now threatened by rapid development which has potential for cumulative impacts on the watershed. (Photo 132 CD)

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